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Experimental Study on Properties of Concrete Using Ceramic Waste as Fine Aggregate and Steel Fiber as Coarse Aggregate

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ABSTRACT- Due to the day to day innovations and development in construction field, the use of natural aggregates is increased tremendously and at the same time, the production of solid wastes from the demolitions of constructions is also quite high. Because of these reasons the reuse of demolished constructional wastes like ceramic tile and granite powder came into the picture to reduce the solid waste and to reduce the scarcity of natural aggregates for making concrete. The ceramic tile waste is not only occurring from the demolition of structures but also from the manufacturing unit. The investigation finds out with the partially replacement of fine aggregate with ceramic waste and steel fiber with coarse aggregate in the concrete mix of M30 was made and fresh and hardness test were examined after 7 and 28 days. The investigation was achieved on cement concrete in which partially replacement of fine aggregate at percentage of 0%, 5%, 10%, 15% and 20% with ceramic waste and steel fiber with coarse aggregate at a percentage of 0%, 10%, 20% and 30% in M30 grade of concrete respectively.

KEYWORDS- Ceramic waste, Steel fibre, Compressive strength, slump test, Split Tensile strength, Abrasion test

I. INTRODUCTION

Concrete is a versatile and widely used building material that is made by mixing together cement, water, and various aggregates such as sand, gravel, or crushed stone. It is a durable and strong material that can be shaped and moulded into various forms and used for a wide range of applications, including foundations, walls, floors, bridges, and highways [1]. The history of concrete can be traced back to ancient civilizations such as the Egyptians, who used a form of concrete to build the pyramids, and the Romans, who developed a hydraulic form of concrete that allowed them to build complex structures such as aqueducts and colosseums. Today, there are many different types of concrete, each with its own properties and characteristics [2]. For example, there are standard concrete mixes that are used for general construction, as well as specialty mixes such as high-strength concrete, self-consolidating concrete, and lightweight concrete. Concrete is a sustainable building material because it can be made from locally sourced materials and is recyclable. It also has excellent thermal mass properties, [3] which can help to reduce energy costs for heating and cooling in buildings. Overall, concrete is a versatile and reliable material that has been used for thousands of years and continues to be an important part of modern construction. Concrete is a versatile and durable building material that is commonly used in construction projects such as roads, bridges, buildings, and dams [3]. It is composed of three main components: cement, water, and aggregate (usually sand and gravel or crushed stone). The cement acts as the binding agent that holds the mixture together, while the water reacts with the cement to initiate a chemical process known as hydration, which results in the hardening of the mixture. The aggregate provides bulk and strength to the mixture. There are many different types of concrete, each with specific properties and uses [4]. For example, reinforced concrete is a type of concrete that has steel bars or mesh embedded in it to increase its strength and resistance to tension, while precast concrete is a type of concrete that is cast into specific shapes or forms at a factory or construction site and then transported to the construction site for installation. One of the main advantages of concrete is its durability and resistance to environmental factors such as moisture, fire, and weather [5]. Concrete can also be produced in large quantities and can be customized to meet specific project requirements. However, concrete can also have some drawbacks, such as its high carbon footprint due to the energy-intensive production process and its susceptibility to cracking over time.

II. FIBER REINFORCED CONCRETE (FRC)

Fiber reinforced concrete (FRC) is a type of concrete that contains fibers to improve its mechanical properties. The fibers can be made from various materials such as steel, glass, synthetic, or natural fibers. The addition of fibers to concrete helps to increase its tensile strength, toughness, and resistance to cracking. FRC can be used in a variety of construction applications such as pavement, bridges, buildings, and tunnels. It can also be used in decorative concrete applications where the fibers can be visible on the surface of the concrete to create interesting patterns and textures [6]. There are two types of FRC: short fiber reinforced concrete (SFRC) and long fiber reinforced concrete (LFRC). SFRC typically contains fibers that are less than 25mm in length, while LFRC contains fibers that are longer than 25mm. The length of the fibers used in the concrete affects the mechanical properties of the concrete. FRC has several advantages over traditional concrete, including increased durability, better resistance to impact and abrasion, and improved crack resistance. FRC can also reduce the need for steel reinforcement in some applications, leading to cost savings and reduced environmental impact. Fiber reinforced concrete (FRC) is a type of concrete that is strengthened by the addition of small, uniformly distributed fibers. These fibers can be made from a variety of materials, such as glass, steel, polypropylene, or carbon, and are typically added to the concrete mixture during the mixing process [6]. The addition of fibers to concrete can improve its mechanical properties, such as tensile strength, flexural strength, and impact resistance. The fibers act as a reinforcement, helping to distribute stresses more evenly throughout the concrete and preventing the formation and propagation of cracks. FRC can be used in a variety of construction applications, including building foundations, bridge decks, pavements, and precast concrete products. It can also be used in shotcrete applications, where the concrete is sprayed onto a surface under high pressure. Overall, FRC is a useful and durable material that can provide increased strength and durability to concrete structures, helping them to withstand the stresses of heavy use and harsh environmental conditions.

III. TYPES OF FIBER USED

Fibers can be added to concrete to enhance its properties, such as toughness, durability, and resistance to cracking [7]. The most common types of fibers used in concrete are:

- *Steel Fibers:* These fibers are made of high-strength steel and are often used in industrial flooring, bridge decks, and shotcrete applications.
- *Polypropylene Fibers:* These fibers are made from synthetic plastic and are often used in residential and commercial applications such as sidewalks, driveways, and parking lots.
- *Glass Fibers:* These fibers are made from glass and are often used in architectural precast products, such as cladding panels and balustrades [7].
- *Synthetic Fibers:* These fibers can be made from a range of materials, including nylon, polyester, and acrylic. They are often used in applications that require high-performance concrete, such as airport runways and highway pavements [7].
- *Natural Fibers:* These fibers can be made from materials such as wood, jute, or sisal. They are often used in decorative concrete applications, such as stamped or stained concrete.

IV. OBJECTIVE OF STUDY

- To examine the workability by using slump test by partially replacing of fine aggregate with ceramic waste and coarse aggregate with steel fiber on M30 grade of concrete.
- To investigate the compressive strength by partially replacing of fine aggregate with ceramic waste and coarse aggregate with steel fiber on M30 grade of concrete.
- To investigate the split tensile strength by partially replacing of fine aggregate with ceramic waste and coarse aggregate with steel fiber on M30 grade of concrete.
- To investigate the abrasion strength by partially replacing of fine aggregate with ceramic waste and coarse aggregate with steel fiber on M30 grade of concrete.

V. METHODOLOGY

This portion deals with the materials used during the inspection process of the work. To investigate by partially replacing of fine aggregate with ceramic waste and coarse aggregate with steel fiber on M30 grade of concrete [8]. In which partially replacement of fine aggregate at percentage of 0%, 5%, 10%, 15% and 20% with ceramic waste and steel fiber with coarse aggregate at a percentage of 0%, 10%, 20% and 30% in M30 grade of concrete respectively The materials are generally used in accordance with the specifications set out in the relevant Indian Standard Codes [9]. The materials used to prepare concrete mix samples had the various properties that were mentioned.

➢ **Materials Used:**

- OPC cement 43 grades
- Ceramic waste
- Sand
- Steel fiber
- Coarse aggregate
- Water

A. Ordinary Portland Cement)

OPC (Ordinary Portland Cement) is a common type of cement used in concrete construction. When OPC is mixed with aggregates (such as sand and gravel) and water, it forms a paste that binds the aggregates together to form concrete. OPC is a versatile and widely used type of cement because it has several advantageous properties, such as good compressive strength, workability, and durability [10]. It also has a relatively fast setting time, which means that it can quickly gain strength and harden. However, it is important to note that OPC is not suitable for all types of concrete construction. For example, if a structure will be exposed to high levels of sulfate or chloride ions, a different type of cement may be required to prevent damage.

Overall, OPC is a commonly used cement in concrete construction, but the specific type of cement and its application will depend on the specific project requirements and conditions [10].

B. Fine Aggregate Sand

Fine aggregate sand is a type of construction material that is used as a component in concrete, mortar, and other construction applications. It is also commonly referred to as fine sand or sand aggregate [11]. Fine aggregate sand is typically composed of small, angular particles that range in size from 0.075 mm to 4.75 mm. It is often used as a filler material to help bind larger particles together in concrete, providing strength and stability to the final product. In addition to its use in concrete, fine aggregate sand is also used in applications such as bedding for pipes and as a base material for pavers [11]. When selecting fine aggregate sand for a construction project, it is important to consider factors such as particle size distribution, shape and texture, and cleanliness. The quality of the sand can have a significant impact on the strength and durability of the finished product. Therefore, it is important to choose a high-quality sand that meets the required specifications for the intended use.

C. Coarse Aggregate

Coarse aggregate is a term used in construction to refer to a type of building material that consists of particles such as crushed stone, gravel, or sand. These particles are typically larger in size than fine aggregates, which are materials such as sand or clay. Coarse aggregates are commonly used in the construction of concrete and asphalt mixtures [12]. In concrete, coarse aggregates provide strength and stability to the finished product, while in asphalt mixtures they provide stability and support. The size of the particles in coarse aggregates can vary, but they are typically larger than 4.75 mm (0.19 inches) in diameter. They are also usually classified by their size, shape, and texture to ensure they meet the desired specifications for the intended use.

Some common types of coarse aggregates include crushed stone, gravel, and sand. These materials are often sourced from quarries or natural deposits and may require processing, [12] such as crushing or screening, to meet the desired specifications. Coarse aggregate is a construction material made from larger-sized rocks or gravel that are typically used in the production of concrete. It is usually composed of particles greater than 4.75 mm (3/16 inch) in size and can be made from a variety of materials such as limestone, granite, or basalt. Coarse aggregates are a key component of concrete and are used to provide bulk and strength to the material. When mixed with cement, water, and fine aggregates such as sand, they form a composite material that is strong and durable [13].

D. Steel Fibers

Steel fiber is a reinforcing material made from small, uniformly sized lengths of steel that are added to concrete or other materials to increase their strength and durability [13]. Steel fibers can be either straight or crimped, and are typically made from low-carbon steel, high-strength steel, or stainless steel. The addition of steel fibers to concrete can improve its structural properties, such as toughness, ductility, and resistance to cracking and fatigue. Steel fibers are commonly used in applications such as industrial floors, airport runways, bridge decks, tunnel linings, and shotcrete for ground support in mining and tunneling [14]. Steel fibers are available in a variety of shapes and sizes, such as hooked, flat, and round. The choice of fiber type and configuration depends on the specific application and the desired performance characteristics. The amount of steel fiber added to the material is typically expressed as a volume or weight percentage of the total mixture. Steel fiber is a type of reinforcement material used in concrete to improve its tensile strength, toughness, and resistance to cracking. Steel fibers are small, discontinuous filaments made of steel that are added to the concrete mixture during the mixing process [14]. The steel fibers can be made in a variety of shapes and sizes, such as straight or crimped, and can vary in length and diameter depending on the specific application. They are typically made from low carbon steel or stainless steel and are designed to resist corrosion and withstand the harsh alkaline environment of concrete. Steel fiber-reinforced concrete (SFRC) is commonly used in industrial flooring, tunnel linings, precast concrete products, and shotcrete applications. The addition of steel fibers to concrete can also help to reduce cracking and shrinkage, increase durability, and improve impact and abrasion resistance. Steel fiber can be added to concrete in different forms, including hooked-end fibers, crimped fibers, and straight fibers [15].

E. Ceramic waste

Ceramic waste refers to any discarded or unused material that is made of ceramic, such as tiles, plates, cups, bricks, and pottery. Ceramic waste can come from a variety of sources, including construction and demolition projects, manufacturing processes, and household items that are no longer in use. Ceramic waste can pose environmental challenges because it is typically non-biodegradable and may take many years to break down in landfills [16]. However, there are some ways to manage and reuse ceramic waste. For example, some ceramic waste can be recycled and used in the production of new ceramic products. Additionally, some artists and designers repurpose ceramic waste into new pieces of art or home decor. Overall, reducing the amount of ceramic waste that is produced in the first place through waste reduction strategies is the most effective way to minimize the environmental impact of this material. This can be done by using durable ceramic products, properly maintaining and repairing them, and donating or reselling them when they are no longer needed. Ceramic waste refers to any discarded or unused ceramic materials that have no further use and are often considered as non-biodegradable waste [16]. Ceramic waste can be generated during the manufacturing, construction, and demolition of ceramic products such as tiles, dishes, vases, and bricks. It can also be produced in households when ceramic items are broken or no longer needed. Ceramic waste can have negative environmental impacts if not properly managed. As non-biodegradable waste, it can take a long time to decompose, and it can also take up a lot of space in landfills.

F. Water in Concrete

Water is an essential component of concrete, which is a composite material made up of cement, water, aggregates (such as sand and gravel), and often other additives. When water is mixed with cement, it undergoes a chemical reaction called hydration, which causes the cement to harden and bind the aggregates together, forming a solid and durable material. However, the amount of water used in the concrete mix is critical, as too much or too little water can affect the quality and durability of the concrete [17]. Too much water can weaken the strength of the concrete, cause cracking, and increase permeability, while too little water can make the concrete stiff and difficult to work with. To achieve the best results, it's important to use the correct water-to-cement ratio, which is the amount of water used in the mix relative to the amount of cement. The ideal water-to-cement ratio can vary depending on the specific application and environmental conditions, but it's generally recommended to use the minimum amount of water required to achieve the desired workability and strength [17]. Water is an essential component of concrete. When mixed with cement and aggregates, it reacts with the cement to form a paste, which binds the aggregates together to create a solid and durable material. The amount of water used in the concrete mix is crucial to the strength and durability of the final product. However, too much water in the concrete mix can lead to a weaker and less durable product, as it can reduce the strength of the concrete and cause cracking and shrinkage. On the other hand, too little water can result in a mix that is too dry and difficult to work with. To ensure the optimal amount of water in concrete, the water-to-cement ratio is calculated and monitored during the mixing process. This ratio is typically between 0.35 and 0.50, with lower ratios producing stronger and more durable concrete. It's important to note that after the initial mixing, excess water can also affect the strength of the concrete. Concrete needs to be properly cured and protected from moisture during its setting and hardening phase to achieve its maximum strength and durability [18].

VI. WORKABILITY

The workability of concrete refers to its ability to be easily mixed, placed, and finished without segregating or losing its homogeneity. It is an important property of concrete as it affects the ease and efficiency of construction, the final appearance and quality of the concrete, and the safety of workers handling it [19]. The workability of concrete is influenced by several factors, including the water-cement ratio, the amount and type of aggregate, the use of chemical admixtures, and the temperature and humidity of the surrounding environment. Generally, a higher water-cement ratio will increase the workability of concrete, but it will also reduce its strength and durability. On the other hand, a lower water-cement ratio will increase the strength and durability of concrete, but it will also reduce its workability [19]. To achieve optimal workability, concrete should be mixed to a consistency that allows it to be easily placed and compacted, while still retaining its shape and strength. Concrete with good workability should be easy to handle, place, and finish, without the need for excessive vibration or tamping. Overall, the workability of concrete is an important factor to consider in the design and construction of concrete structures, and it can be adjusted through careful selection of materials and proper mix design. Concrete is a widely used construction material because of its strength, durability, and workability. Here are some factors that affect the workability of concrete:

- ***Water-cement ratio*:** The amount of water in concrete affects its workability. Higher water content makes concrete more workable, but it can also result in lower strength and durability.
- ***Aggregate properties*:** The size, shape, and texture of the aggregate used in concrete affect its workability. Rounded and smooth aggregates are more workable than angular and rough aggregates [20].
- ***Admixtures*:** Chemical admixtures can be added to concrete to improve its workability. For example, plasticizers can increase the workability of concrete without increasing the water content.
- ***Temperature*:** The temperature of the concrete and the surrounding environment can affect its workability. Higher temperatures can make concrete more workable, but they can also cause it to set more quickly [20].
- ***Mixing method*:** The mixing method used to prepare the concrete affects its workability. Overmixing can cause the concrete to lose its workability, while undermixing can result in uneven distribution of aggregates and air pockets.

Overall, workability is an important property of concrete that affects its ease of placement and the quality of the finished product. It is important to consider the factors that affect workability when designing and preparing concrete for use in construction [21].

VII. COMPRESSION TEST

A compression test of concrete is a standard procedure used to determine the compressive strength of concrete. This test is essential in the design and construction of concrete structures to ensure that they can withstand the anticipated loads and forces.To conduct a compression test, a cylindrical or cube-shaped sample of concrete is prepared, usually by casting it in a mould. The sample is then cured under controlled conditions, typically for 28 days, to allow the concrete to reach maximum strength [21].Once the sample has cured, it is placed in a compression testing machine that applies a gradually increasing load until the sample fails. The load at which the sample fails is recorded as the compressive strength of the concrete. The compressive strength of concrete is usually reported in units of pounds per square inch (psi) or megapascals (MPa). The test results are typically used to determine if the concrete meets the specified strength requirements for a particular application.It's important to note that the compressive strength of concrete is affected by many factors, including the water-to-cement ratio, the curing conditions, the type of aggregate used, and the age of the concrete [22]. Therefore, it is crucial to carefully follow the testing procedures and control the variables as much as possible to obtain accurate and meaningful results. Compression testing is a commonly used method to evaluate the strength of concrete. It involves applying a compressive force to a concrete cylinder or cube until it fails, and then measuring the maximum load that it can withstand.

VIII. ABRASION STRENGTH

The abrasion testing machine shall be the same –as described in Annex F of IS 1237. Square-shaped specimen measuring 71.0 + 0.5 mm shall be cut from the block specimens selected as per the sampling procedure [22]. The contact face and the opposite face of the specimen shall be parallel and flat. For determining the reduction in thickness as described in E-4, the opposite face shall, if appropriate, be ground parallel or otherwise machined so as to be parallel [22]. For testing dry specimens, the specimens shall be dried to constant mass at a temperature of 105+ 5"C. For testing wet/saturated specimens; the specimens shall be immersed in water for 7 days and wiped with a damp artificial sponge prior to each weighing so that all specimens appear equally damp.

IX. SPLIT TENSILE STRENGTH

Split tensile strength is a measure of the tensile strength of a material, which is determined by applying a tensile load to a cylindrical or prismatic specimen along its axis and measuring the resulting tensile stress [23]. Unlike conventional tensile testing, which applies the load along the longitudinal axis of the specimen, split tensile testing involves applying the load perpendicular to the axis of the specimen, which causes it to split. In split tensile testing, a cylindrical or prismatic specimen is placed between two parallel plates, and a compressive load is applied along the axis of the specimen until it fractures [24]. The tensile stress is then calculated based on the applied load, the geometry of the specimen, and the location of the fracture. Split tensile strength is commonly used to evaluate the tensile strength of concrete, which is an important parameter for assessing its durability and resistance to cracking [24]. It can also be used to evaluate the tensile strength of other materials, such as rock, asphalt, and wood.

X. SLUMP TEST

The slump test is a standard test used in the construction industry to measure the consistency or workability of concrete. It is a simple and quick test that involves filling a metal cone with freshly mixed concrete, tamping it down, and then lifting the cone to see how much the concrete slumps or settles [25]. The test is performed by placing the cone on a flat, non-absorbent surface and filling it with three equal layers of concrete, each layer being tamped down 25 times using a standard tamping rod. After the third layer is tamped, the excess concrete is struck off the top of the cone with a trowel, and the cone is slowly lifted vertically, allowing the concrete to slump or settle. The amount of slump is measured by the difference in height between the top of the cone and the highest point of the slumped concrete. This measurement is typically recorded in millimeters or inches and gives an indication of the workability of the concrete [25].

XI. RESULTS AND DISCUSSION

A. Slump Test

The slump test is the workability test for concrete, involves low cost and provides immediate results. Due to this fact, it has been widely used for workability tests since 1922. The slump is carried out as per procedures mentioned in astm c143 in the united states, is: 1199 – 1959 in india and en 12350-2 in europe. Generally concrete slump value is used to find the workability, which indicates water-cement ratio. Table no. 1 and figure no. 1 shows variation in slump used in investigation.

Table 1: Variation In Slump With Fly Ash And Chopped Jute Fiber

Mix	Replacement of coarse aggregates by steel fibbers	Replacement of fine Aggregate by ceramic tile wastes	Height of frustum cone (mm)	Height of sample (mm)	Slump (mm)
MS01	0	0	300	222	78
MS02	10	5	300	225	75
MS03	10	10	300	228	72
MS04	10	15	300	231	69
MS05	10	20	300	235	65
MS06	20	5	300	236	64
MS07	20	10	300	239	61
MS08	20	15	300	243	57
MS09	20	20	300	247	53
MS10	30	5	300	251	49
MS11	30	10	300	255	45
MS12	30	15	300	259	41
MS13	30	20	300	262	38

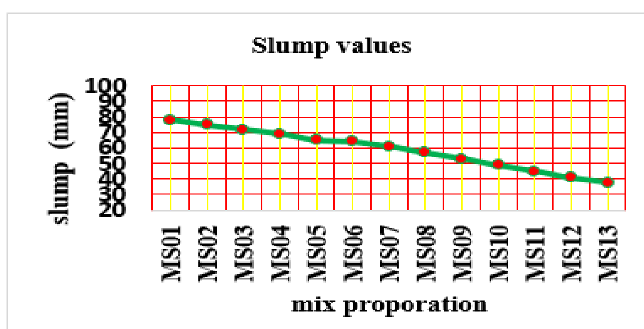

Figure 1: Slump Variation

The workability of the concrete mix increases the increase in the ceraic waste and steel fiber m30 grade of concrete.

B. Compressive strength Test

The compressive strength tests on specimens of different mixes were tested after 7 days and 28 days of curing is analyzed and represented in this section. For the construction work, the size of 15 cm x 15cm x 15 cm was selected. Then the concrete mix prepared is poured into the mold is thoroughly tampered to eliminate voids. After 24 hours cube specimens are carried out and then immersed in water for curing. To procure smooth surface, cement paste is spread uniformly on the surface area of specimen. The rate of loading is 350 kg/cm2/minute and uniform. Concrete cube specimens were tested after 7 days and 28 days of curing. Specimens stored in water should be tested immediately after they are taken from water. Compression test was performed on standard compression testing machine of 2000 kn capacity in the usual manner as per indian standard guidelines.

Table 2: Compressive Strength after 7 Days Compressive Strength after 7 Days

Mix	%age of coarse aggregates	%age of steel fibbers	%age of fine aggregates	% age of ceramic wastes	Compressive strength after 7 days (N/mm^2)
MS01	100	0	100	0	25.72
MS02	95	5	90	10	25.93
MS03	90	10	90	10	26.64
MS04	85	15	90	10	27.72
MS05	80	20	90	10	28.37
MS06	95	5	80	20	28.83
MS07	90	10	80	20	29.40
MS08	85	15	80	20	30.21
MS09	80	20	80	20	31.33
MS10	95	5	70	30	30.70
MS11	90	10	70	30	30.12
MS12	85	15	70	30	29.55
MS13	80	20	70	30	28.91

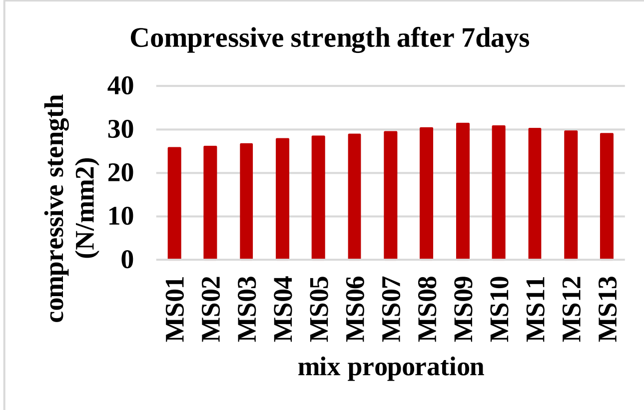

Figure 2: Compressive Strength after 7 Days

The compression strength of 7 days concrete was examiner and was found out to be 31.33n/mm2 when the sand was replaced with ceramic waste by 20% and steel fiber with coarse aggregate at 20% in the concrete mix of m30 which was designated mix ms09.

The compressive strength of M30 is present in table 3 the results of compressible strength of concrete with varying percentages of ceramic waste and steel fiber aggregate are shown graphically in figure 3 as shown below.

Table 3: Compressive strength after 28 days Compressive strength after 28 days

Mix	%age of coarse aggregates	%age of steel fibbers	%age of fine aggregates	% age of ceramic wastes	Compressive strength after 28 days (N/mm^2)
MS01	100	0	100	0	38.32
MS02	95	5	90	10	38.61
MS03	90	10	90	10	39.22
MS04	85	15	90	10	39.85
MS05	80	20	90	10	40.65
MS06	95	5	80	20	41.77
MS07	90	10	80	20	42.21
MS08	85	15	80	20	42.35
MS09	80	20	80	20	43.31
MS10	95	5	70	30	43.78
MS11	90	10	70	30	44.25
MS12	85	15	70	30	43.55
MS13	80	20	70	30	42.45

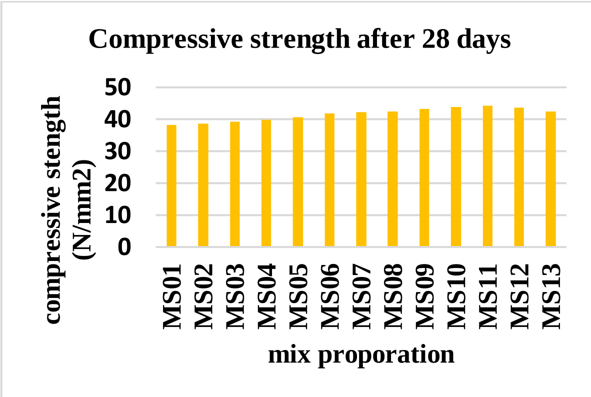

Figure 3: Compressive Strength after 28 days

The compression strength of 28 days concrete was examiner and was found out to be 44.25N/mm2 when the sand was replaced with ceramic waste by 30% and steel fiber with coarse aggregate at 10% in the concrete mix of M30 which was designated mix MS11.

C. Split Tensile Strength

Split tensile strength is a measure of the tensile strength of a material, which is determined by applying a tensile load to a cylindrical or prismatic specimen along its axis and measuring the resulting tensile stress [23]. Unlike conventional tensile testing, which applies the load along the longitudinal axis of the specimen, split tensile testing involves applying the load perpendicular to the axis of the specimen, which causes it to split. In split tensile testing, a cylindrical or prismatic specimen is placed between two parallel plates, and a compressive load is applied along the axis of the specimen until it fractures [24]. The tensile stress is then calculated based on the applied load, the geometry of the specimen, and the location of the fracture. Split tensile strength is commonly used to evaluate the tensile strength of concrete, which is an important parameter for assessing its durability and resistance to cracking [24].
The split tensile strength was observed at 7 days and 28-days of concrete mixes. Tensile tests were conducted on concrete cylinders of size 150 x 300 mm cast from concrete of each proportion.
Split tensile strength of m30 are presents in table 4 the results of split tensile strength of concrete with varying percentages of ceramic waste and steel fiber aggregate are shown graphically in figure 4.

Table 4: Split Tensile strength after 7 days split tensile strength after 7 days

Mix	%age of coarse aggregates	%age of steel fibbers	%age of fine aggregates	% age of ceramic wastes	Split tensile strength after 7 days (N/mm^2)
MS01	100	0	100	0	4.13
MS02	95	5	90	10	4.23
MS03	90	10	90	10	4.29
MS04	85	15	90	10	4.35
MS05	80	20	90	10	4.4
MS06	95	5	80	20	4.46
MS07	90	10	80	20	4.49
MS08	85	15	80	20	4.55
MS09	80	20	80	20	4.61
MS10	95	5	70	30	4.58
MS11	90	10	70	30	4.53
MS12	85	15	70	30	4.47
MS13	80	20	70	30	4.43

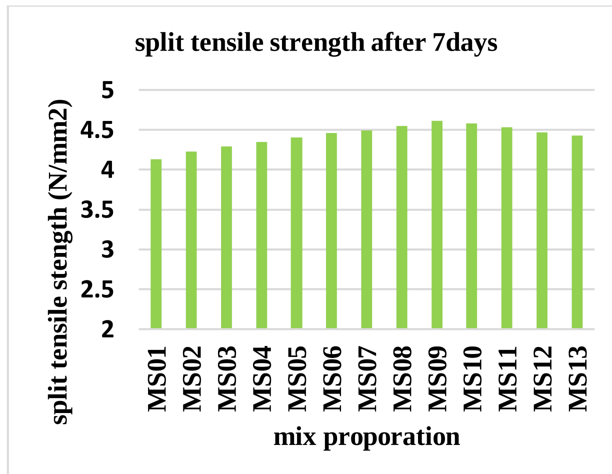

Figure 4: Split Tensile Strength after 7 Days

The split tensile strength was achieved maximum at ms09 which was 4.6 n/mm2 for 7 days when the sand was replaced with ceramic waste by 20% and steel fiber with coarse aggregate at 20% in the concrete mix of m30 which was designated mix ms09.
Split tensile strength of m40 solidified concrete cylinder specimens after 28 days. One of the important properties of concrete is “tensile strength” as structural loads make concrete vulnerable to tensile cracking. This is obtained by performing split tensile test on concrete specimen. The cylindrical mold shall be of 150 mm diameter and 300 mm height conforming to is: 10086-1982. The tensile strength of concrete is much lower than its compressive strength (that’s why steel is used to carry the tension forces). After the specimens are removed from the molds to be submerged in clean fresh water for curing period (such as 7 or 28 days). The split tensile strength of m30 is present in table 5. The results of split tensile strength of concrete with varying percentages of ceramic waste and steel fibbers are shown graphically in figure 5.

Table 5: Split Tensile Strength After 28 Days Split Tensile Strength After 28 Days

Mix	%age of coarse aggregates	%age of steel fibbers	%age of fine aggregates	% age of ceramic wastes	Split tensile strength after 28 days (N/mm^2)
MS01	100	0	100	0	5.14
MS02	90	10	95	5	5.28
MS03	90	10	90	10	5.36
MS04	90	10	85	15	5.45
MS05	90	10	80	20	5.63
MS06	80	20	95	5	5.72
MS07	80	20	90	10	5.87
MS08	80	20	85	15	5.96
MS09	80	20	80	20	6.06
MS10	70	30	95	5	6.15
MS11	70	30	90	10	6.19
MS12	70	30	85	15	5.97
MS13	70	30	80	20	5.82

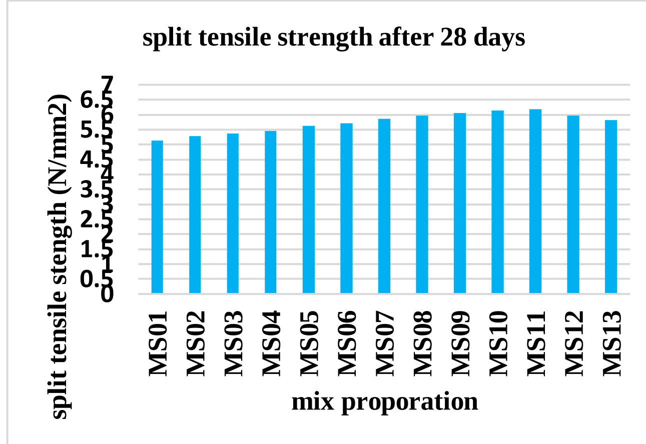

Figure 5: Split Tensile Strength After 28 Days

The Split Tensile Strength Was Achieved Maximum At Ms11 Which Was 6.19 N/Mm2 For 28 Days When The Sand Was Replaced With Ceramic Waste By 10% And Steel Fiber With Coarse Aggregate At 30% In The Concrete Mix Of M30.

D. Abrasion Test

The abrasion testing machine shall be the same –as described in annex f of is 1237. Square-shaped specimen measuring 71.0 + 0.5 mm shall be cut from the block specimens selected as per the sampling procedure in 8 and as per the number of specimens mentioned in table 4. The contact face and the opposite face of the specimen shall be parallel and flat. For determining the reduction in thickness as described in e-4, the opposite face shall, if appropriate, be ground parallel or otherwise machined to be parallel. For testing dry specimens, the specimens shall be dried to constant mass at a temperature of 105+ 5"c. For testing wet/saturated specimens; the specimens shall be immersed in water for 7 days and wiped with a damp artificial sponge prior to each weighing so that all specimens appear equally damp.

The abrasion strength of m30 is present in table 6. The results of abrasion test of concrete with varying percentages of ceramic waste and steel fibbers are shown graphically in figure 6.

Table 6: Abrasion after 7 Days

Mix	Initial wt (g)	Initial size (cm)	Initial vol (cm^3)	Wt after 8 cycles	Wt after 16 cycles	Avgwt	Δwt	Δ vol	Density (g/cm^3)	Abrn value (Δt) cm
MS01	745.6	7×7×7	343	738.94	729.4	734.17	11.43	4.70	2.43	0.096
MS02	748.4	7×7×7	343	742.55	732.04	737.30	11.10	4.46	2.49	0.091
MS03	748.2	7×7×7	343	742.04	734.11	738.07	10.13	4.12	2.46	0.084
MS04	747.7	7×7×7	343	742.77	734.38	738.58	9.12	3.72	2.45	0.076

MS05	747.3	7×7×7	343	742.93	734.45	738.69	8.61	3.53	2.44	0.072
MS06	752.2	7×7×7	343	750.24	737.55	743.89	8.31	3.28	2.53	0.067
MS07	751.9	7×7×7	343	754.43	734.86	744.64	7.26	2.89	2.51	0.059
MS08	751.7	7×7×7	343	754.63	734.92	744.77	6.93	2.79	2.48	0.057
MS09	751.4	7×7×7	343	754.42	735.12	744.77	6.63	2.70	2.46	0.055
MS10	754.5	7×7×7	343	757.91	738.25	748.08	6.42	2.50	2.57	0.051
MS11	754.2	7×7×7	343	757.91	738.49	748.20	6.00	2.35	2.55	0.048
MS12	753.8	7×7×7	343	758.27	737.88	748.07	5.73	2.25	2.54	0.046
MS13	753.4	7×7×7	343	758.46	737.72	748.09	5.31	2.11	2.52	0.043

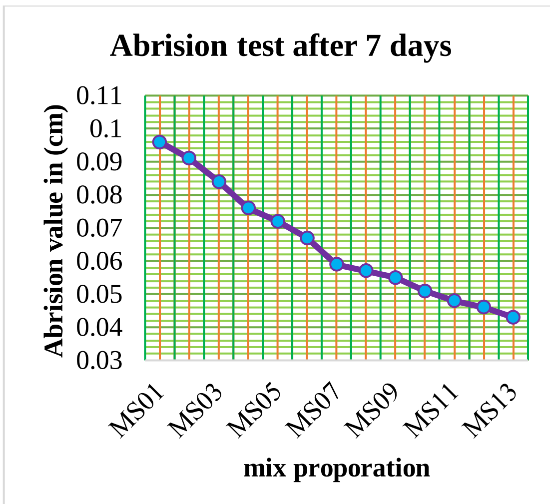

Figure 6: Abrasion Strength after 7 Days

The abrasion strength value of concrete decreases with the increase in replacement of material for both 7 days and 28days respectively.

Table 7: Abrasion Strength after 28 Days

Mix	Initial wt (g)	Initial size (cm)	Initial vol (cm^3)	Wt after 8 cycles	Wt after 16 cycles	Avgwt	Δwt	Δ vol	Density (g/cm^3)	Abrn value (Δt) cm
MS01	746.2	7×7×7	343	745.60	730.4	738.6	7.62	3.14	2.43	0.064
MS02	748.6	7×7×7	343	747.60	732.7	741.2	7.44	2.99	2.49	0.061
MS03	749.3	7×7×7	343	748.40	734.4	742.3	6.99	2.84	2.46	0.058
MS04	749.8	7×7×7	343	748.70	735.3	743.1	6.72	2.74	2.45	0.056
MS05	751.1	7×7×7	343	750.20	737.5	744.8	6.34	2.60	2.44	0.053
MS06	752.8	7×7×7	343	751.50	738.9	746.5	6.32	2.50	2.53	0.051

MS07	751.9	7×7×7	343	751.30	739.5	746.0	5.90	2.35	2.51	0.048
MS08	752.4	7×7×7	343	751.50	740.6	746.9	5.47	2.21	2.48	0.045
MS09	752.2	7×7×7	343	759.40	730.4	747.3	4.94	2.01	2.46	0.041
MS10	754.8	7×7×7	343	753.20	743.6	750.0	4.79	1.86	2.57	0.038
MS11	754.6	7×7×7	343	752.90	743.9	750.1	4.50	1.76	2.55	0.036
MS12	753.8	7×7×7	343	752.70	744.5	749.7	4.11	1.62	2.54	0.033
MS13	753.2	7×7×7	343	752.40	744.7	749.4	3.83	1.52	2.52	0.031

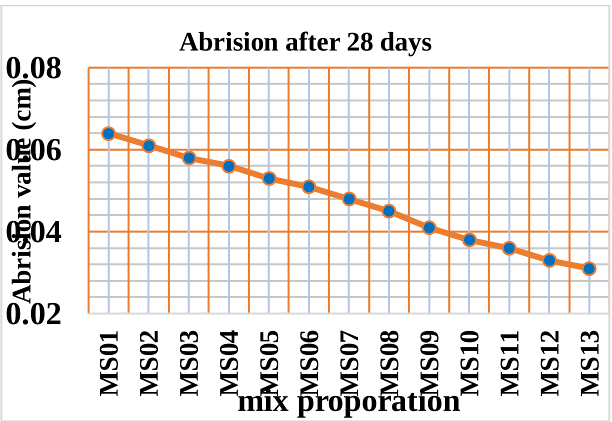

Figure 7: Abrasion Strength after 28 Days

XII. CONCLUSION

During the investigation it was find out with the partially replacement of fine aggregate with ceramic waste and steel fiber with coarse aggregate in the concrete mix of m30 was made and fresh and hardness test were examined after 7 and 28 days. The investigation was achieved on cement concrete in which partially replacement of fine aggregate at percentage of 0%, 5%, 10%, 15% and 20% with ceramic waste and steel fiber with coarse aggregate at a percentage of 0%, 10%, 20% and 30% in m30 grade of concrete respectively. The results are summarized in following pointers.

- The workability of the concrete mix increases with the increase in the ceramic waste and steel fiber m30 grade of concrete.
- The compression strength of 7 days concrete was examiner and was found out to be 31.33n/mm2 when the sand was replaced with ceramic waste by 20% and steel fiber with coarse aggregate at 20% in the concrete mix of m30 which was designated mix ms09.
- The compression strength of 28 days concrete was examiner and was found out to be 44.25n/mm2 when the sand was replaced with ceramic waste by 30% and steel fiber with coarse aggregate at 10% in the concrete mix of m30 which was designated mix ms11.
- The split tensile strength was achieved maximum at ms09 which was 4.6 n/mm2 for 7 days when the sand was replaced with ceramic waste by 20% and steel fiber with coarse aggregate at 20% in the concrete mix of m30 which was designated mix ms09.
- The split tensile strength was achieved maximum at ms11 which was 6.19 n/mm2 for 28 days when the sand was replaced with ceramic waste by 10% and steel fiber with coarse aggregate at 30% in the concrete mix of m30.
- The abrasion strength value of concrete decreases with the increase in replacement of material for both 7 days and 28days respectively.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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